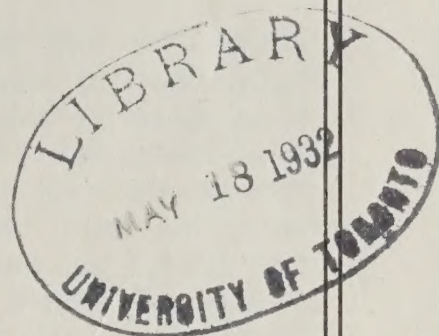


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By ERIC HEARLE
ASSISTANT ENTOMOLOGIST




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Warble Flies and Their Control in Canada

By ERIC HEARLE, *Assistant Entomologist, Dominion Entomological Laboratory, Kamloops, B.C.*

The warble flies of cattle are fairly large, dark, hairy flies with bands of yellow or orange which give them a superficial resemblance to small bumblebees. The two species have become very widely distributed in many parts of the world, particularly in Europe, North America, and to a less extent in Asia, and constitute the worst insect pests of cattle wherever they are abundant. They occur in every part of Canada where stock is raised. They are injurious both as adults, due to their terrifying effect on cattle when egg laying, and as parasitic grubs in the body, due to their effect on the health, condition and milk yield of infested animals, and their damage to hides into which the grubs bore holes for the purpose of breathing. While the normal hosts are cattle, they will occasionally attack other animals, and grubs have been noted in horses, American buffalo and goats. Infestation in man has been reported on many occasions.

The life-histories and habits of the two species have many points in common. Eggs are laid during bright sunny days on the legs and lower parts of the animal and are attached to the hairs. The small grubs hatch in from three to seven days, penetrate through the skin, and migrate through the tissues of the host, in some cases congregating in numbers in the region of the gullet. They remain here during the summer and until late winter, when they undertake a second migration and come to rest under the skin of the back, which they perforate in order to make breathing holes. After about two months in this position, during which time they feed on matter in the tumor-like cysts formed, they squeeze their way through the breathing holes, drop to the ground, and pupate as hard, black, seed-like objects measuring nearly three-fourths of an inch in length. Emergence of the adult flies occurs in from one to two months; mating may take place on the same day and egg-laying commence, an average of about 400 eggs being laid during the life of the female. While the individual life of adults is very short, about a week in nature, the period of adult activity is a long one of five months beginning in April, since successive adults are developing and emerging during this period, and one species appears later on the wing than the other. The total period of development from egg to egg requires about a year and at least nine months of this is passed as a grub in the host animal.

THE COMMON CATTLE GRUB OR HEEL FLY (*Hypoderma lineatum* de Villers)

The common heel fly is the smaller of the two species and is approximately one-half inch in length. Much of the body is clothed with black hair, but there are broad areas of pale yellowish hair at the sides of the thorax and base of the abdomen. The latter is tipped with reddish orange hairs. The pale and dark hairs on the thorax are sparse on the fore part, and do not obscure the four distinct dark marks or lines in this location. The legs are rough and hairy.

Warble fly surveys undertaken in various sections of the Dominion indicate that this species is very generally distributed and is common in almost every district where stock farms occur.

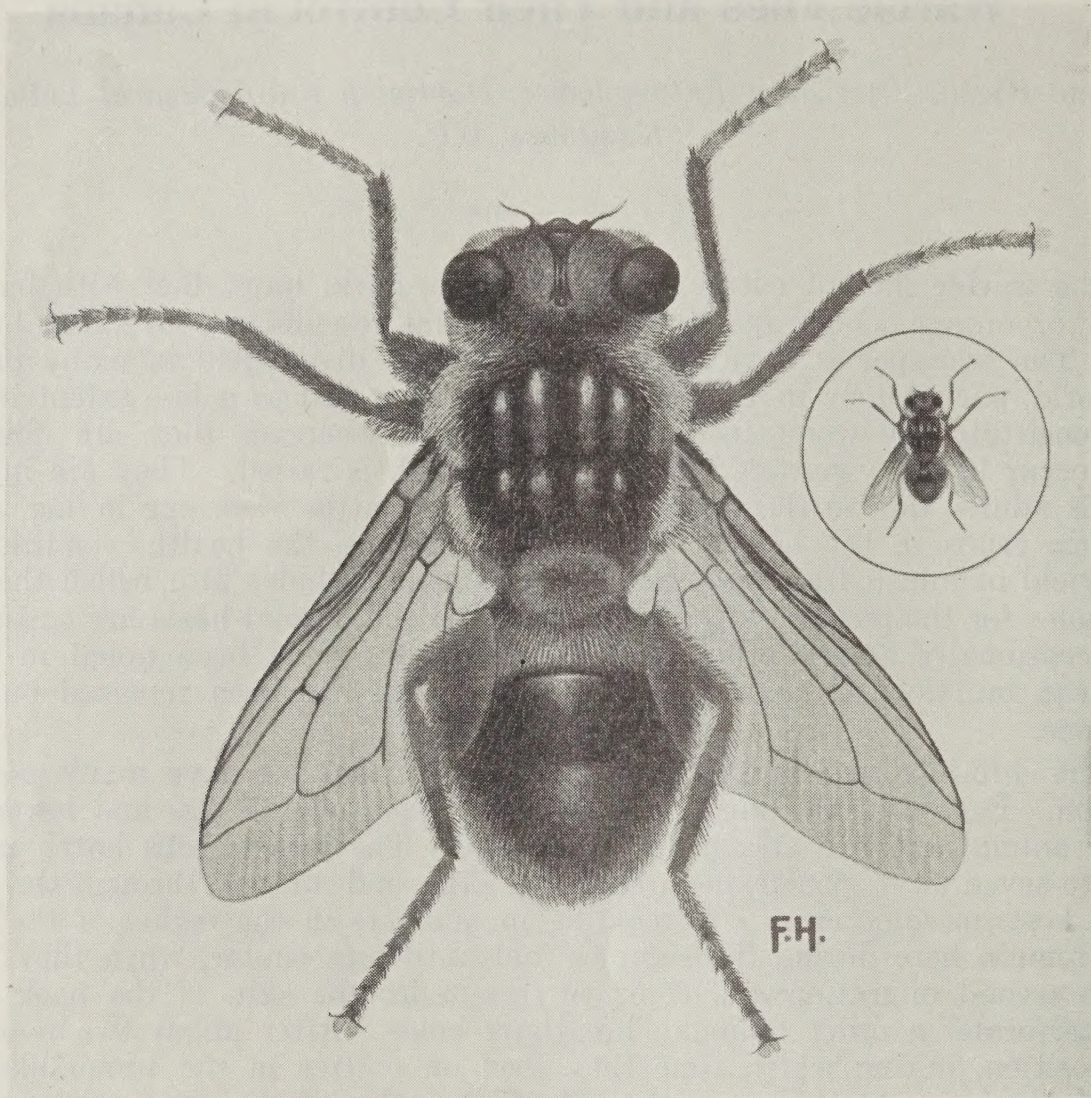


FIG. 1.—The common cattle grub or heel fly, *Hypoderma lineatum* de Villers, (original).

This species is the earlier of the two, and adults usually appear on the wing during the first warm days of the spring, and, over much of Canada, the period of adult activity is from April until June. Bright sunshiny days are favoured for egg laying, but the insect appears to prefer laying its eggs on the shaded parts of the body. "It has the habit of settling on the ground in the shade of the heels of a cow and reaching up with its long egg tube to attach its eggs to the hairs of the coronet. When cattle are lying down the fly lays its eggs on parts of the body which come close to the ground. The line runs from a point six inches below the pin bones, along the flanks to the elbow, and the sides of the brisket,"¹ as shown in the accompanying illustration. It is usually very quiet and careful in its attack, and is less likely to cause gadding than the rougher and less stealthy large warble fly. The eggs are laid in series of from a few to a dozen or more and are firmly cemented to the hairs by a clamping arrangement at the base; they are usually placed about midway along a hair, and are, therefore, not readily discernible. From 400 to 500 eggs may be laid by each female.

¹ Hadwen, S.: Dom. Dept. Agric., Bul. 29, p. 16.

The minute white grubs, which hatch in from four to seven days, immediately crawl down the hair to the skin and bore through this until they disappear in the underlying tissue. Adult cattle resist the penetration of the grubs by a reaction which takes place in the skin. "A swelling occurs where the grubs have gone in, and watery matter exudes, forming a scab which can be lifted off, leaving a small conical pit filled with pus."¹ This rash and swelling has been given the name "hypodermal rash." Undoubtedly many of the grubs are destroyed by this reaction, and this may be one of the main reasons why adult cattle seldom mature as many grubs as do younger animals which have not yet developed this defensive reaction. The grubs migrate through the body to the walls of the gullet, where they may be found in large numbers. They first reach this location in June, and the last individuals to leave this situation do so in March; they are at their greatest abundance here in mid-winter. Usually the larvæ are in the body for about two and a half months before appearing

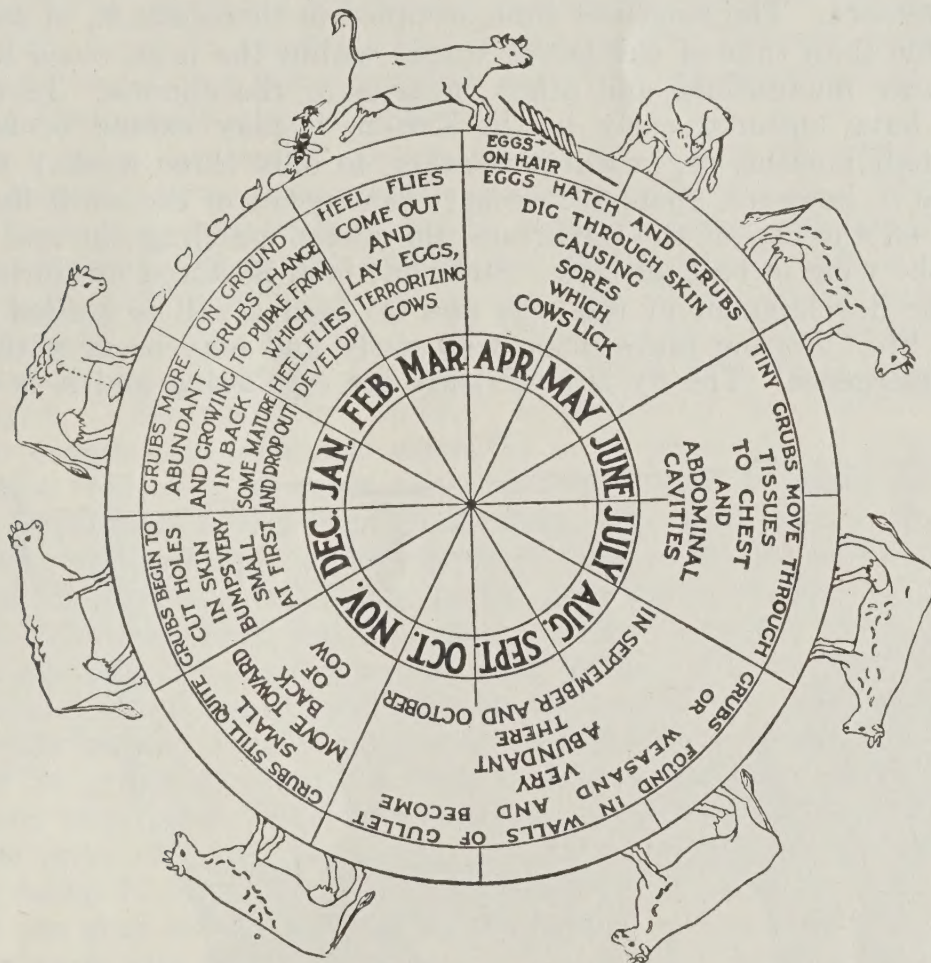


FIG. 2.—Showing life cycle of common cattle grub, or heel fly, *Hypoderma lineatum* de Villers (redrawn after Bishopp, Laake and Wells).

in the gullet. They later make a second migration, enter the spinal canal and pass along until they reach the region of the loins, and then ascend to take up their position under the skin, through which they bore small breathing holes. The time at which the larvæ reach their position in the back is of the utmost importance in control procedure, and for this reason it has been the subject of considerable investigation in various parts of Canada. In the warm coastal sections of British Columbia, grubs of this species may first appear as early as mid-December, although they are seldom in very noticeable numbers until the first and second week in January. In colder interior parts of the province, however, they seldom make an appearance until mid-January. In Ontario, late

¹ Hadwen, S.: Dom. Dept. Agric., Bul. 29, p. 16.

December is the first period for grubs to appear, although they do not become abundant until late January or early February, and in the prairie provinces grubs seldom become numerous in the back until late February.

Infestation of the backs of cattle by this species may extend over several months as successive grubs migrate to this position. There is some variation in different districts. The grubs are nourished by the matter formed in the tumor-like cysts which they inhabit, and they develop slowly. The period during which the grubs occupy the cysts in the back averages about two months, but Bishopp states that this period may occasionally be as short as 35 days, or may sometimes be prolonged to 89 days. The grub is white at first and darkens towards maturity. It is during the two months that the grub is under the back that the insect is most vulnerable, and can best be dealt with by control measures. On reaching maturity the grub works its way through the enlarged breathing hole in the skin, drops to the ground and seeks a shady location, and within a day turns into a hard, black, seed-like puparium incapable of movement. The length of time occupied in this stage is, of course, much more variable than that of the larval stages within the host, since it is subject to temperature fluctuations and other vagaries of the climate. In the case of grubs that have matured early in the season, it may extend occasionally to two and a half months, or, in warm weather, to only three weeks; the average pupal period is, however, about six weeks. Emergence of the adult fly is effected by pushing off the cap of the puparium, the insect crawling out and being able to take to the wing in half an hour. Sufficient food is stored up during the grub stage for the development of the eggs and no food at all is needed during the short adult life. Mating takes place very early and may occur within an hour or two of emergence. The fly is now ready for egg-laying and it is during this

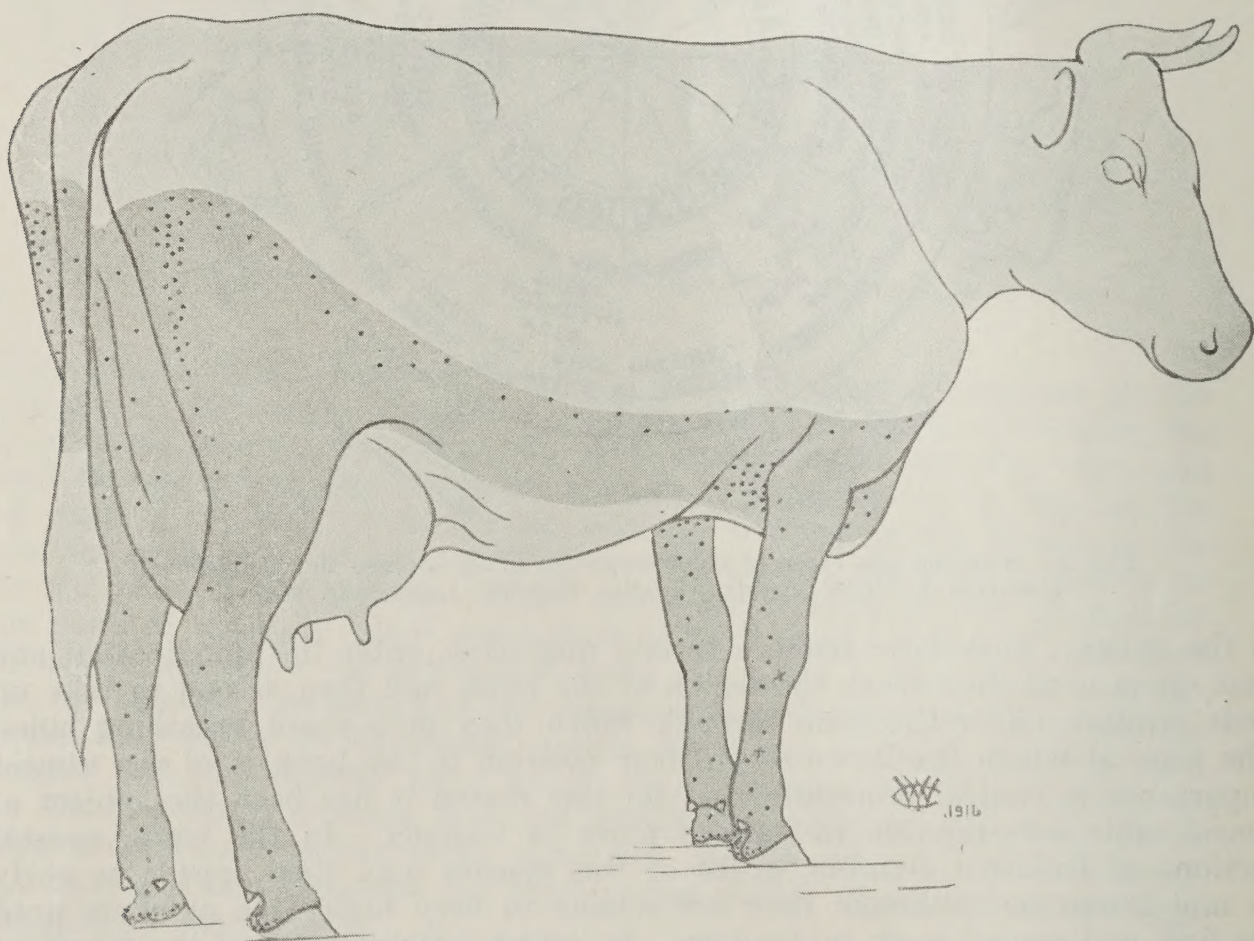


FIG. 3.—Showing the regions where warble fly eggs are deposited. The black spots indicate the places where most eggs have been found and the shaded parts the whole area where eggs may be deposited (after Hadwen).

process that cattle often become terrified and with upraised tails and terror-stricken eyes, run from their small tormentors. Owing to its quieter habits and more cautious approach, this species is less feared by the animals than its larger and rougher relative.

THE NORTHERN CATTLE GRUB OR LARGE WARBLE FLY

(*Hypoderma bovis* de Geer)

As indicated by its common name, this species is slightly larger than the common heel fly. The fore part of the thorax is more densely clothed with a quantity of yellow hair which obscures the four lines or marks characteristic of the other species. The tail end is orange instead of red, and the legs are smoother and less hairy.

The large warble fly has been found to be almost as widely distributed in Canada, and to be nearly as common as the smaller species. Varying weather conditions may, however, cause seasonal fluctuations in the two species, and fine weather conditions during the egg-laying period of one species may cause it to predominate temporarily over the other.

This is a later developing species and adults are on the wing from early June until August, and are particularly annoying during July. The egg-laying activity is even more restricted to bright sunshiny days than is the case with the common heel fly. Eggs are seldom laid on an animal that is lying down, and are usually laid fairly high up on the legs. They are invariably placed singly on the hairs and not in rows as in the case of the other species dealt with. Since an equally large number are laid, this results in a more frequent, intermittent attack. This and the rougher behaviour of the insect explains the greater fear experienced by cattle when the large warble fly is annoying them. The eggs take from four to seven days to hatch, and as soon as the larva emerges it burrows into the skin. Following the penetration of the newly hatched grub, swellings appear, but these are not so severe as those caused by the common heel fly, and only older cattle show them. Little is known of the movements within the body, but this species does not appear to select the gullet region as a resting place for the second stage grubs. The migration to the back commences one or two weeks later than in the case of the common heel fly, and the first grubs usually reach this position in February or March; the period over which the grubs move to the back is longer and may extend to June, or in some years even later. The time occupied by the individual grubs under the back is also more extended than with the other species, the average length of this period being 72 days, according to Bishopp. There is no difference in the position of the grub in the back or in the injury caused. The pupal period is not so long as in the previous species, as one would expect from the warmer weather conditions to which most of the grubs are subjected; the average length of this stage is one month. Egg-laying commences in June, about a week after the smaller heel flies have ceased their activities. It may continue until August.

DAMAGE CAUSED BY WARBLE FLIES

We have stated that warble flies constitute the most serious pest of cattle wherever they are common, but it is evident that even those well acquainted with the live stock industry seldom realize the full extent of the losses involved. Estimates by the United States Bureau of Entomology place the annual losses in that country at the enormous sum of from \$50,000,000 to \$100,000,000. Dr. W. E. Graham, of the Dominion of Canada National Research Council, as a result of a recent very extensive survey, finds that "at the very minimum 50 per cent of all Candian hides taken off in 1930 were damaged by open or healed

grub holes, and on this basis Canadian hides were worth \$700,000 less in finished leather in that year than if they had been clear." The total losses in Ontario have been stated by the Provincial Zoologist to be \$5,000,000 a year. We estimate that the losses from all causes attributable to warble flies throughout the Dominion are from \$7,000,000 to \$14,000,000, and in some seasons may even exceed the latter figure.

These losses are the result of both direct and indirect injuries.

Damage is occasioned by fright and worry to animals during the period of adult fly activity when egg laying is taking place. Milk yields are reduced and animals do not gain as they should, due to worry and interference in grazing. Range herds often become almost unmanageable during this period, and occasionally animals will seriously injure themselves in attempting to escape from the flies.

Damage is occasioned to the hides by the grub infestation. Badly infested animals become unthrifty and do not gain as they should. Milk production is reduced if grubs are numerous. Wastage of much valuable meat is necessitated through butchers having to trim off "licked beef" from the best parts of the carcass. Hide injury due to grub holes and to scars from old grub holes forms the most obvious source of loss; 30 per cent of all hides received throughout the year in Canada are grubby, and 50 per cent to 60 per cent are affected during the grub season from January to June. Since badly infested hides are practically worthless for many purposes, Canadian tanners are obliged at times to import large quantities of foreign hides. Blow flies occasionally lay their eggs at pus-exuding grub holes, and the animals become "struck" with maggots. Magpies are also attracted, and have been known to cause serious injury. A condition known as "anaphylactic shock" may occasionally occur in animals if grubs break in the back.

WARBLE FLY CONTROL

The complete eradication of warble flies, at least from restricted areas, is not merely a theoretical possibility, but has actually been demonstrated.

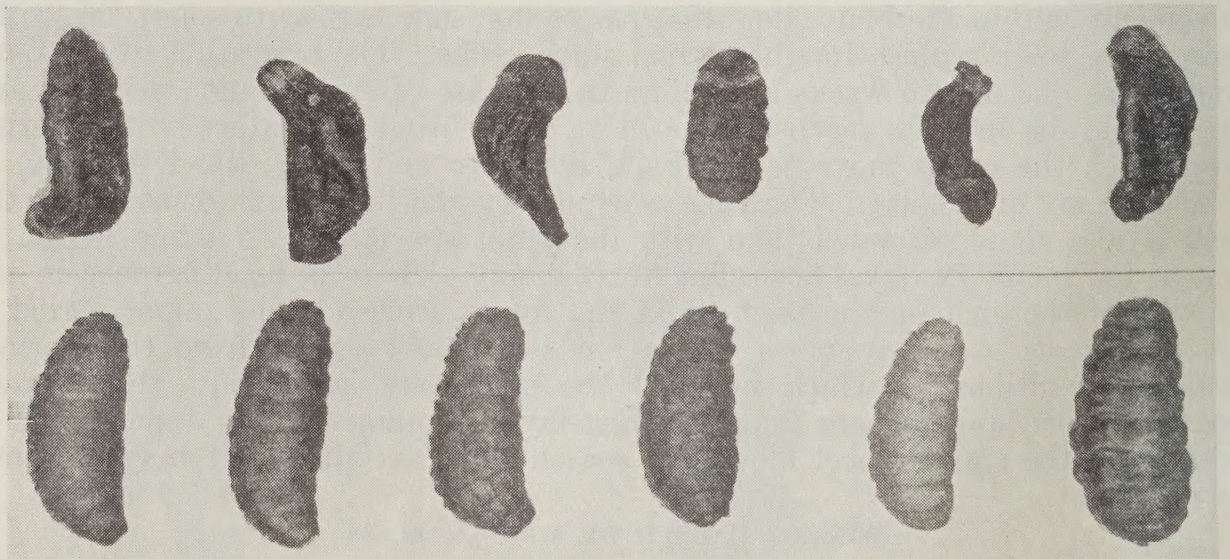


FIG. 4.—Warble grubs: lower figures, normal plump grubs from untreated cattle; upper figures, blackened and shrivelled dead grubs from cattle treated with derris soap wash, (original).

Absolute freedom from this pest has been attained in Clare Island, Ireland, after five years of systematic control work. This demonstration was a comparatively small one involving only about 400 head of cattle, and was carried out under nearly ideal conditions, but larger demonstrations in England, America, Germany and Denmark, have shown that very material reduction in warble damage

is quite feasible. In the latter country compulsory control legislation was enacted in 1923. In the previous year 29½ per cent of all hides were grubby, but after three years' operation of the Act grubby hides were reduced to 2½ per cent, and complete eradication is anticipated through continuance of the control measures employed.

Reduction of warble fly damage may be effected in a number of different ways. The housing of animals during the daytime or the provision of darkened sheds or brush shelters will greatly reduce grub infestation, as it protects the cattle from the egg-laying activities of the flies. If shelters are available the cattle will make for them the minute warble flies appear. Access to sloughs and shallow stretches of water provides some protection, since the flies will not molest animals standing in water.

Many live stock owners rely implicitly on the application of repellent dressings or "fly dopes" to their stock as a protection against warble fly trouble, but experimental work has failed to substantiate the practical value of any known repellents in this respect.

Since development of warble grubs is almost entirely restricted to cattle, and since the grubs are in an accessible position in the back for some time during a definite seasonal period, it is evident that this is the weakest spot in the whole complicated life cycle. At no other period can the insects be so easily controlled. Hand extraction is a method that has given remarkably good results where systematically undertaken. In the case of such soft-skinned breeds as Jerseys and Guernseys, squeezing out grubs by pressure of the fingers around the cysts is not a particularly difficult matter, but with tough-skinned animals, such as Holsteins, this is an extremely laborious undertaking that would have but little chance of general acceptance under ordinary Canadian farm conditions. Enlarging the aperture with a sharp knife has objectionable features, but the use of special forceps for this purpose is of great assistance. The herd should be gone over when the grubs first appear, in January in most districts, and the process repeated five or six times at intervals of not more than 30 days. If a grub breaks, the cyst should immediately be washed out with dilute disinfectant to avoid danger of anaphylactic shock. It is quite erroneous to believe that grubs can only be removed when they are fully developed or "ripe."

To obviate the difficulties involved in hand extraction, experiments have been undertaken in many parts of the world to find materials that would kill the grubs in the back without injuring the host animals, and this method has of recent years been very strongly advocated. A number of washes, ointments and powders have been discovered which will accomplish these results. The United States Bureau of Entomology undertook detailed tests of two or three hundred substances in this connection, and there is no lack of effective materials. Their multiplicity, however, is apt to be confusing, and the following criterion should be applied to any substance used: it must have good killing properties and should destroy at least 80 per cent of the grubs present; it should be harmless to the host animal, and, for dairy cattle, be odourless, so that there may be no danger of tainting milk; it should be in a form that ensures cheap and easy application, and should in itself be inexpensive; it should also either be procurable ready for use or at least involve no complicated or slow process of preparation. Keeping qualities when mixed are also of some importance.

Fortunately there are several materials that meet these qualifications, the most promising having as their base an insecticide known as derris, tobacco and pyrethrum powder. Derris as a wash has proved most effective in large scale experiments in Great Britain, and R. C. Gaut, of the Worcestershire County Council, published a report in the fall of 1930 dealing with the treatment of 21,000 cattle. Four applications have been found to be sufficient under conditions in Great Britain, and while these may be sufficient in the prairie provinces,

an additional earlier dressing is required in British Columbia and parts of Ontario owing to the earlier appearance of grubs in the back in these sections. Taking January 7 as the general date of first appearance of the grubs, the first dressing should be made about February 11. The second and third, after intervals of 28 days, on March 11 and April 8 respectively; and the fourth and fifth on May 13 and June 17 respectively, after intervals of 35 days. The longer intervals between the last dressings are in consideration of the longer period of larval development in *Hypoderma bovis*. In colder regions where the grubs appear later, the first dressing may be omitted.

Preparation and application are fairly simple, the quantities of materials being as follows: Standardized derris¹ powder 1 pound, soft soap $\frac{1}{4}$ pound, water 1 gallon. The soft soap is boiled in a quart of water and when cooled a little is poured into the derris powder in a bucket and mixed into a paste. Cold water is added slowly while stirring to make up to one gallon, and the mixture is then ready for use. It should be liberally applied to the backs of the animals with a soft cloth or a worn stable brush, care being taken to cover completely the area affected by the grubs. A crush or dehorning shute is an aid to the handling of animals that are not stall tied. The kill is usually 100 per cent. The material must be agitated frequently during use to ensure good mixture. The keeping qualities are good if the mixture is placed in a well stoppered container. It was found in the English experiments mentioned that the cost of materials for four dressings did not need to exceed 3 cents for each animal treated. Recent tests at Kamloops indicate that costs in Canada would be only slightly in excess of this.

A wash similarly applied, but made with nicotine sulphate 2 ounces, fresh hydrated lime 1 pound, and water 1 gallon, is very effective and gives over 80 per cent kills. The water should be poured slowly on to the lime while stirring to prevent formation of lumps, and the tobacco extract added last. The liquid should be used only when freshly mixed.

When weather conditions are so severe that herdsmen are disinclined to wet the backs of their animals, finely powdered derris or a tobacco-lime powder may be substituted for the washes in the earlier dressings. The latter mixture is particularly recommended and can be prepared on the farm from materials that are very generally available. The commercial firms dealing in nicotine sulphate supply pamphlets describing in detail the methods of mixing the dust, and the construction of simple home mixers for this purpose. A 2 per cent dust with finely powdered lime as a base is very satisfactory, but Tripoli earth has some advantages as a base if it can be obtained. Only 3 ounces of the powder should be dusted over the back of each animal, since there is a little danger of slight burning if a more general application is made. The dusts should be applied on the same dates as mentioned under washes.

Ointments of derris, pyrethrum, iodoform, etc., with vaseline and sweet oil as a base, may be applied to the openings of the cysts and will give good kills, but, while effective, some grubs are apt to be missed and oily substances act as a preservative on the dead grubs and delay their absorption or expulsion. The method also involves considerably more time and labour. The last-named substance has been widely recommended, but we do not advise its general use on account of the danger of the pungent odour tainting milk. Some of the large dairy organizations are strongly opposed to the use of iodoform for any purpose in dairy barns.

¹ Derris is not at the present time easily procurable in Canada, but would undoubtedly be placed on the market if there was sufficient demand for it. A standardized derris powder has been prepared by one of the largest and best known British firms specializing in insecticides and dipping materials, and retails in Eastern Canada at about one dollar per pound package.

While the reduction of warble flies still offers some difficulties in the case of range animals, the above control measures in general farming and dairy districts would greatly reduce or even exterminate the pest, if generally undertaken on a community basis. Suitable legislation and supervision by competent trained veterinarians would undoubtedly be essential before this ideal condition could be realized. Canadian farming conditions are less simple than those in Denmark, but in the more important dairy sections there is no reason to believe that warble flies could not be brought under control by the measures outlined above.

Under present hide marketing methods there is little incentive for farmers to undertake warble grub control with a view to reducing hide injury (although even omitting hide injury, any efforts at control are well worth while on account of losses from reduced milk yield, unthriftiness and health of grub-infested animals). Hide and leather dealers in England have recently secured a reform in hide marketing practice whereby hides clear of warble holes are given a premium on the market amounting to about 34 per cent. This is an inducement to control warble grubs, and could be followed with advantage in Canada.

